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THE U.S. NATIONAL PLANT GERMPLASM SYSTEM AND FORTHCOMING LEGAL ISSUES ON GERMPLASM RIGHTS

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The U.S. National Plant Germplasm System

While the U.S. National Plant Gemplasm System (NPGS) has been functioning informally for over 30 years, its role was formally established in 1990 legislation authorizing the National Genetic Resources Program (P. L. 101-628). The U. S. Department of Agriculture's Agricultural Research Service (ARS) is charged with the specific role to acquire, characterize, preserve, document, and distribute germplasm to scientist-users for research and breeding. The NPGS (Figure 1) focuses to serve the user community. Interfacing with the users are the working elements (Table 1) of the system: the service activities, the active collections, and the base collection. The next tier bridges the operations and policy elements of the NPGS and the final tier involves the administrative and financial support elements. In their NPGS administrative roles, in addition to ARS, are other Federal agencies such as the Animal and Plant Health Inspection Service (APHIS), interested scientists and administrators from the State Agricultural Experiment Stations System and from the private sector. Over forty Crop Advisory Committees (CACs) composed of Federal, State, and private sector scientists and administrators representing commodities or commodity groupings help assess and prioritize activities relating ot their specific interests. The focus is on user groups, Particularly the breeders, makes the Crop Advisory Committees vital to thesuccess of the system. All parties provide recommendations on how best to achieve the long-range goals of conservation and utilization.

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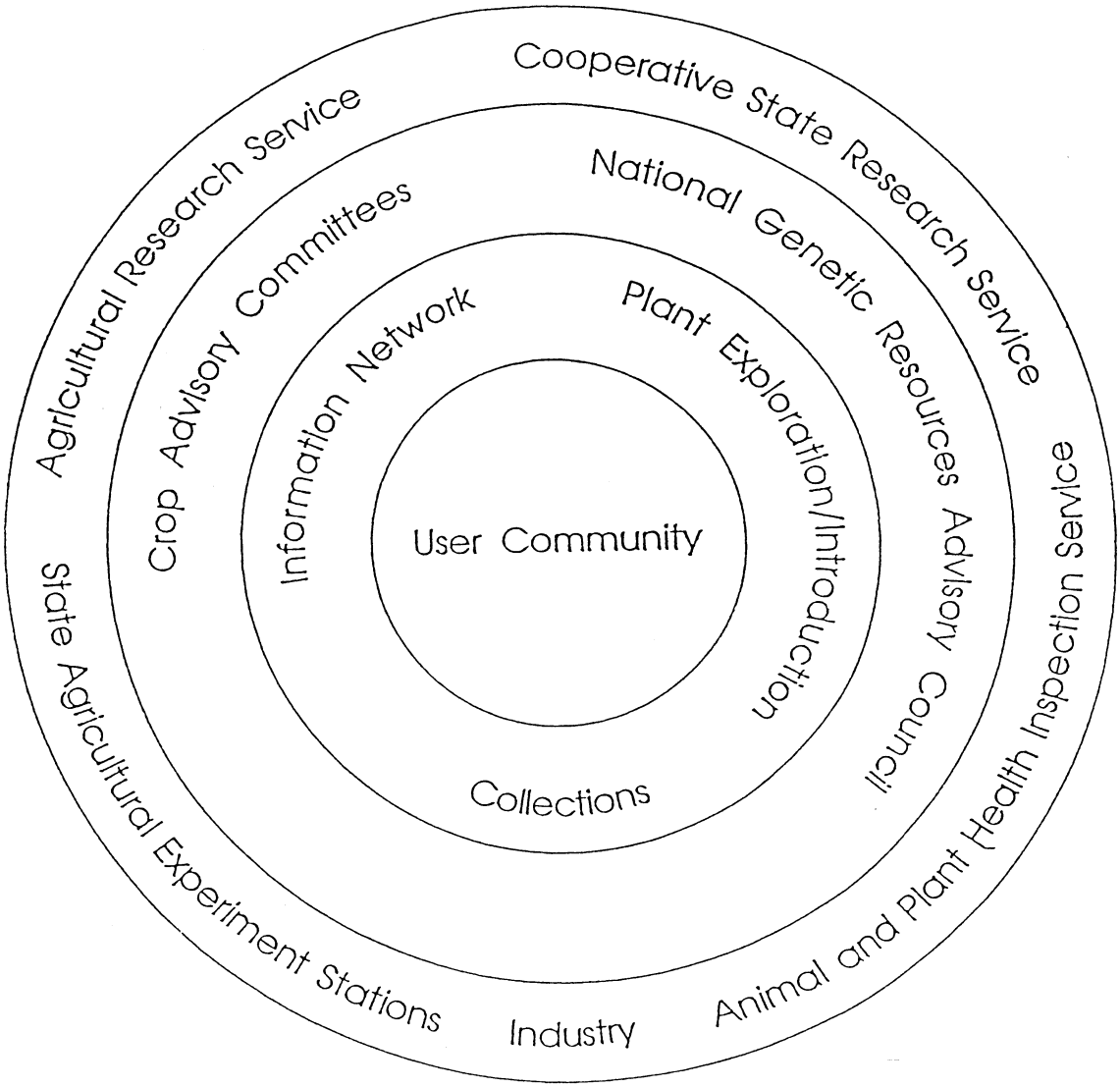

Figure 1. The U.S. National Plant Germplasm System Network-Focus and Support.

Table 1. Simple structure of the U.S. National Plant Germplasm System. August, 1993.

Working Elements of the National Plant Germplasm System:
National Germplasm Resources Laboratory
Active Collections (Seed & Clonal Repositories, Special Collections, Genetic Stock Collections)
Base Collection (National Seed Storage Laboratory)

There are several very important service functions housed within the National Germplasm Resources Laboratory (NGRL) at Beltsville (Table 2.). The underlying structure of the NPGS is a network of sites managing and servicing the germplasm program and linked together through the Germplasm Resources Information Network (GRIN). GRIN serves as the electronic connection with a database of germplasm, authoritative taxonomic listing of plant material, an order processing system and system distribution tabulator, and electronic mail for use by technicians, managers, and administrators of the system. Upgrading the capabilities of the database in the future will increase the use of the electronic medium in system management. While some changes will have significant up-front costs, the benefits over time will prove the wisdom of the changes. One example is the use of digitizd picture records of the germplasm taken at the time of collection, upon receipt, at growout, and of the germination test. Electronic storage media are becoming less expensive and pictures will be helpful to managers and users alike to supplement herbarium voucher specimens. Other services of the NGRL critical to an efficient system include: an acquisition office which deals with expeditions, introductions and germplasm management, and a quarantine center to process germplasm and assure to the country that it is free from exotic pathogens and insects. ARS and APHIS share in the responsibilities at the National Plant Germplasm Quarantine Center at Beltsville and a special satellite center for field quarantine introductions of sorghum and maize on St. Croix, Virgin Islands under the direction of the Germplasm Introduction Unit at Mayaguez, Puerto Rico.

Table 2. Components of the National Germplasm Resources Laboratory, Beltsville, Maryland. August, 1993.

Elements of the National Germplasm Resources Laboratory:
Germplasm Resources Information Network (GRIN)
Plant Exploration Office
Plant Introduction Office
Plant Quarantine Office
Crop Advisory Committee Facilitation

Of the working elements of the NPGS, the active sites form the nucleus for the interface of the user community with the system through the database. The active sites may be for seed (Table 3) or vegetaive (Table 4) collections or both , multiple or unitary crops (Table 5) or a genetic stock collection (Table 6). They interact closely with the National Genetic Resources Laboratory and the National Seed Storage Laboratory. Some of the major collections are listed (Table 7). These sites manage the collections, conduct research and provide and/or process most the data entering the database regarding their crops. Growouts are increasingly being shifted to Western states under dry but irrigated conditions to gain production efficiencies and obtain improved seed quality and quantity. Growouts in humid zones often result in seeds carrying disease organisms or of lower quality due to drought or temperature stress. This usually results in lower seed germinability making them less suitable to enter into the long-term storage genebank or be eligible for phytoasnitary certificates for shipment. The system needs no longer fit well within the political boundaries of the cooperative state system. As. activities are shifted to develop stronger efficiency in the system, the state system might shift to National Research Support Project funding to alleviate pressure on the Regional funds. Also, active sites are developing more capacity for long-term storage for their small seed size species, for their less-used accessions, and for their non-core and reserve collections to gain more efficiency.

The USDA's National Seed Storage Laboratory at Fort Collins, Colorado serves to house the U.S. base collection and conduct research related to storage methodologies and the collection's health and stability. Active collection sites arrange for growout and manage distribution of the collections.

Table 3. Accessions held at the Regional Plant Introduction Stations' active collections. August, 1993.

Location	No. Accessions
Ames, IA	40,844
Griffin, GA	67,344
Geneva, NY	12,944
Pullman, WA	52,304
Total	173,436

Table 4. Accessions held in active collections at National Clonal Germplasm Repositories. August, 1993.

Location	No. Accessions
Brownwood, TX	191
Corvallis, OR	7,779
Davis, CA	5,884
Geneva, NY	4,744
Hilo, HI	549
Miami, Fl/Mayagiiez, PR	5,341
Riverside, CA	901
Washington, DC	1,665
Total	27,054

Table 5. Some crop specific active collections of the U.S. National Plant Germlasm System. August, 1993.

Location	No. Accessions
National Small Grains Collection	118,055
Soybean Collection	14,228
Cotton Collection	6,085
Potato Collection	5,232
Flax Collection	2,659
Tobacco Collection	2,076
Total	148,335

Table 6. Some genetic stock active collections of the U.S. National Plant Germplasm System. August, 1993.

Crop	Location
Barley	Ft. Collins, CO
Brassica	Madison, WI
Clover	Lexington, KY.
Cotton	College Station, TX
Lettuce	Salinas, CA
Maize	Urbana, IL
Pea	Geneva, NY
Pepper	Las Cruces, NM
Sorghum	College Station, TX
Soybean	Ames, IA
Tomato	Davis, CA
Wheat	Columbia, MO

Table 7. Some selected agricultural crops maintained in active collections of the U.S. National Plant Germplasm System (NPGS). August, 1993.

Crop	Accessions	Location
Wheat	46,776	Aberdeen, ID
Corn	28,401	Ames, IA
Soybean	15,981	Urbana, IL
Potato	11,072	Sturgeon Bay, WI
Tomato	9,969	Geneva, NY
Peanut	8,394	Griffin, GA
Alfalfa	7,095	Pullman, WA
Cotton	6,834	College Station, TX
Grape	4,188	Davis, CA/Geneva, NY
Apple	3,952	Geneva, NY
Pear	2,004	Corvallis, OR
Citrus	779	Riverside, CA

CACs provide important guidance to the management needs of germplasm of the commodities represented (Table 8). They cover all sectors and many disciplines (Table 9). They provide useful reports to system managers and administrators (Table 10).

One of the strengths behind the present USDA system is the strong commitment of ARS to research. Research on conservation biology issues of biochemistry, genetics, and seed and plant physiology drives the system at Ft. Collins and other NPGS sites. Too little is known about: the biological basis of seed survival despite some major breakthroughs in recent years;

Table 8. Current status of NPGS Crop Advisory Committees. August, 1993.

No. of CAC's:		40
Members (excluding *Ex-Officio*):		475
ARS	109	
State	213	
Private sector	130	
Other (NGO, foreign, IARC)	23	
Ex-Officio : Curators, NPS		
No. members per CAC:	Range (6 to 18)	

Table 9. CAC composition by discipline. August, 1993.

Discipline	Number
Botany	11
Chemistry	2
Entomology	14
Food science	3
Genetics	344
Microbiology	1
Nematology	1
Pathology	41
Physiology	6
Virology	6

Table 10. Suggested CAC Annual Report Contents for Administrators and Managers of the NPGS.

Accomplishments:
New accessions
Regenerations
Distributions
Evaluations
Priority Needs:
Collection
Regeneration
Evaluation
Enhancement
Plan of work for next year
Issues requiring special attention

and cryopreservation of vegetatively-propagated germplasm; the impact of diseases harbored in the seeds; genetic shifts in storage; and, population sizes for regeneration and retention of integrity of landrace populations. Research is essential for quarantine aspects of plant introduction and distribution. Plant collecting and exchanges of germplasm between scientists have been the primary means of germplasm distribution since the commencement of formal institutional plant breeding efforts. All nations are vulnerable to importing and spreading damaging exotic plants, diseases and insects. Research requires considerable support from the performing organization and from the government planners recognizing the importance and risks of new introductions. New molecular technologies give the research community tools to attack priority diseases to determine the causative organism and its etiology and to develop the protocols to deal with it.

Management tools must receive more attention. New research is needed to develop criteria and protocols for more efficient and cost-effective ways for conservation of the biological materials. Development of rational criteria by which the "core collection" concept is implemented is critical to the commodity groups. Little is known about the practical application of the core collection concept. Recent examples in the United states

where breeders were searching for sorghum greenbug biotype I resistance, resistance to a new form of barley stem rust attacking the T gene, and wheat and barley resistance to the Russian wheat aphid suggest that the predicted 70 percent of genetic diversity contained in a hypothetical core collecion would have been inadequate to provide the breeders the resistant germplasm sources they needed. In each case, the frequency of resistant germplasm found in the gene bank was less than one percent. Strategies for constituting a core collection with a higher frequency of total diversity need to be developed. An assist from molecular markers may be necessary to supplement more conventional data and statistics. Unfortunately, it is easy to look to the molecular technologies as being the solution to all problems while forgetting that the cost of molecular analysis is high and that, for large collections , there may be a physical limits to getting a job done in a reasonable time and cost.

Large collections accumulated may create major management problems for a system. It is easy to rationalize the need for adding more and more. Some of the traditional logic: 1) we can't count on being able to receive the genetic resources in the future from some country or region due to genetic erosion, politics, and so on; 2) we can get it now, store it, and rationalize it with our present collection later; 3) we have a foolproof way to eliminate the seedborne viruses (bottlnecking the collection); and 5) the advisory committee recommends that we should get it.

Breeding developments in the future will depend on efficiencies derived from utilizing higher technologies and greater information exchange. Genome mapping is advancing rapidly and will play an important role in speeding future crop development successes. Genetic stock collections established for many crop species provide unique mutant marker gene reference points and have potential importance for deciphering genetic codes, and orienting, verifying, and effectively using the comparative species maps.

With the competition of many societal needs for funds, how can we do our jobs better with less real money in the future? The answers may lie in responses to a series of questions. What international cooperation is possible given the problems of environment, pathogens and quarantine, and politics in exchanges. What role can the International Agricultural Research Centers (IARCs) play? Is the real cost of conservation the cost of doing it, or the cost of not doing it and when will it be too late to make the decision? What is the cost of genetic materials unavailable for use? What is the cost of lost viability of samples? What is it the real cost of

diverting the limited funds to acquisition activities (quarantine growouts, greenhouses, isolation) while the present samples need more characterization to improve usefulness? A number of the questions relate to symptoms of an over ambitious collection policy and the lack of the discipline to complete the job at hand.

In 1993, a survey of CACs revealed that over half of them felt that their genetic base was too narrow and that additional germplasm is needed. At the same time their priorities were 1) to better characterize the existing collection, 2) expand growout facilities in field and greenhouse, 3) enter accessions into the database at repository sites, and - to a lesser degree - 4) clean up disease-infected collections. A relatively small number felt that a core collection was needed for their crop. From a management viewpoint, this pressure of acquiring more must be rationalized with system capacity and quality work.

Forthcoming Legal Issues on Germplasm Rights

Agriculture's capacity to provide food, clothing, shelter, fuelwood, some phytomedicinals and industrial chemicals depends on a large extent on conservation and breeding efforts. Changes in social and industrial policy must arrest the genetic erosion and the conservation effort must preserve what we have. Effective breeding strategies and procedures must be developed utilizing new technologies in the most efficient ways. Gains in productivity over the past half-century have been the result of a combination of many factors in management and improved plant types. Production increases in developing countries resulting from new management practices and breeding germplasm releases by IARCs has been unprecedented. Developed countries have also benefitted from utilizing some of these breeding materials. No matter how one looks at those gains, the composite result has come from germplasm exchanges between developing and developed countries and a commitment of countries to work together.

There is a serious concern about the access to and exchange of germplasm in the future. Recently, with the advent of biotechnology patents, intellectual property issues have complicated the exchanges and left, unresolved, a protocol for the future, The U.S. has several laws affecting property protection for plant germplasm (Table 11). Within the

U.S., the State public sector is being pressed to recover costs in the genetic resources sector just as in other sectors. Thus, the pressure for product sales to recover revenue in the State public sector emulates that of the private sector and has raised the question what is the private sector when the public organizations enter competitively into the marketplace against the private sector. This changing interest of the State universities has left the plant breeding and germplasm communities with much uncertainty and concern. In time, potential profit centers of state experiment stations might be sold off as was done with the Cambridge Plant Breeding Institute in the United Kingdom. Meanwhile, the Federal sector, under terms of the Technology Transfer Act of 1986, will likely also be under additional pressure to recover costs in some way, perhaps through increased partnerships with industry. Other countries are also struggling with the need to generate research funds not at the expense of the taxpayer.

A future protocol will also be concerned with how countries will work with each other on matters involving access to genetic resources and, in particular, those genetic resources having intellectual property protection of some form. The expectation of large profits is driving some countries to seek compensation for providing basic germplasm resources from which commercialization utilizes some critical component. The IARCs have already declared that the genetic resources provided freely to them are in trust to benefit the world's people. An emerging material transfer agreement (MTA) of the IARC's will likely have a provision that any genetic material exchanged cannot be protected in any way to prevent its use by others.

The United Nations Environment Programme's Convention on Biological Diversity (CBD) provides a legal umbrella to request compensation for providing genetic resources. Countries must recognize that instituting charges for genetic resourecs may be more costly long run. It is to the benefit of the agricultural economies of all nations to continue to exchange germplasm resources freely. Relationships between the legal status of the CBD and FAO International Undertaking on Plant Genetic Resources in areas affecting exchange are compared by the bilateral-multilateral arrangements, the charge-free for exchange, and the time of implementation (Table 12). Due to the interdependence of countries for different commodities, all nations will continue to be best served well through free and open exchange. There are countries failing to exchange freely at this time and others will likely do so in the future. The marketplace will bring that into balance at some point in time. Payment for

access is what the CBD advocates. What happens to the poorer countries, the less able countries, the less prepared countries? The "Lost Decade", when the FAO issues clouded many activities, must not be repeated for the conservation aspects of plant genetic resources. Fortunately, the IARCs continued about their business: production agriculture.

There is an opprtunity for the IARCs and their donor supporters to build upon Center strengths to make some essential changes in genetic resources conservation and crop protection. While individual IARCs have recognized the eco-regional conservation need, there is not adequate funding to expand this to a broader genetic resources base and conservation of minor and local crops, and their relatives. The donor organizations have the responsibility to urge development of regional implementation plans to collect, preserve, and utilize--in concert with the nations of the region--genetic resources of importance to the agro-ecosystems of the world, to conduct research and provide training for the participants from those nations, and to press for a more sustainable agriculture in all countries. Utilization of modern biotechnologies as employed in the IARCs will enable the technologies to be instituted in developing country programs. As national programs become competitive globally, there will be increasing interest in establishing an adequate and effective intellectual property system to enable the countries to protect, exchange, and benefit from their works. In the meantime, there will likely be continued difficulties to exchange and protect material.

There will be a renewed interest on the part of the Conference of the Parties to the Convention on Biological Diversity to show that it is instituting action plans on the scientific and legal fronts. Scientists the world over must do their part to collaborate and keep the germplasm flowing as freely as possible while recognizing that they are exchanging germplasm, technologies, and information on mutually agreed terms. Any national legislation which interrupts this flow through increased bureaucracy or restrictive regulations will do that country and the world a great disservice. The Conference of Parties should acquire agricultural expertise through sub-committee to assure that the world's people have access to a continued bountiful food and agricultural production through better conservation of genetic resources and development of improved crop cultivars and hybrids.

Table 11. Intemational and U.S. Legal Protection for Plant Genetic Resources.

	UPOV Convention	Patent Law	Proposed Federal Research Exemption
Legal Act:	Plant Variety Protection Act	Utility Patent Act; Plant Patent Act	Utility Patent Act Proposed Federal Reqt.
Int' Nat'l:	Multilateral	Bilateral	Bilateral/Multilateral
Access Terms:	Open & no cost- No infringement for Research/Breeding	Terms of Material Transfer Agreement (MTA)	Open & no cost- Universal MTA Terms
Commercailization	Essentiall derived requirement	Terms of MTA	Universal MTA Terms

Table 12. Options of Access to Genetic Resources under International Conventions.

	FAO Undertaking	UNEP Convention	UNEP Convention
Treaty:	Non-binding	Binding	Binding
Arrangement:	Multilateral	Bilateral	Bilateral
Access option:	Open and no cost	Open and no cost	Payment for access
Terms:	None; No direct commercialization	Royalties upon commercialization	Royalties upon commercialization